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Bad moon on the rise? Lunar cycles and incidents of crime ☆

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A B S T R A C T

Popular cultures in Western societies have long espoused the notion that phases of the moon influence human behavior. In particular, there is a common belief the full moon increases incidents of aberrant, deviant, and criminal behavior. Using police, astronomical, and weather data from a major southwestern American city, this study assessed whether lunar cycles related with rates of reported crime. The findings fail to support popular lore, which has suggested that lunar phase influenced the volume of crime reported to the police. Future research directions examining qualitative rather than quantitative aspects of this problem may yield further inform the understanding of whether lunar cycles appreciably influence demands for policing services.

It is the very error of the moon;
She comes more near the earth than she was wont,
And makes men mad.
-Othello, Act V, Scene II

Introduction

Western lore has long suggested a relationship between the phases of the moon and various forms of aberrant, antisocial, deviant, and criminal human conduct. Popular thinking, visual arts, drama, and literature have expressed this notion well beyond the legend of vampire, werewolves, witches, and warlocks. The root of the word "lunatic" is "luna," Latin for "moon" (Merriam-Webster Online Dictionary, 2008). Even in contemporary times with considerable advances in scientific knowledge, there was a continued belief that lunar phases effect human behavior (Lieber, 1996; Rotton & Kelly, 1985; Rotton, Kelly, & Elortegui, 1986) including limited evidence of a high rate of belief among mental health care providers (Vance, 1995). An on-going debate concerned whether lunar effects could be empirically verified; that is, whether "a disproportionate number of deviant or abnormal episodes occur when the moon is full" (Culver, Rotton, & Kelly, 1988, p. 684).

Policing, crime, and criminal justice have not been immune from speculation concerning the lunar-crime relationship. In working with police officers on a wide range of research projects, the authors frequently heard individuals express the belief that the quality and/or quantity of activity were linked with full moons (see also Lieber, 1996, p. 21). Such beliefs have been systematically verified through surveys of police officers (Rotton et al., 1986; Vance, 1995). The study reported herein examined the lunar-crime relationship using five years of policing, astronomical, and weather data from a major southwestern American city. The results were inconclusive in supporting what popular lore would suggest being true. With few exceptions the moon's phase was not related with the level of crime and disorder reported to the police, controlling for relevant weather conditions. The limited significant findings would tend to contradict the lunar lore, suggesting that when lunar phase mattered it constrained, rather than increasing, targeted forms of aberrant behavior.

How might lunar phase affect behavior?

The cultural lore concerning lunar effects is vague in describing the specific ways and reasons for the moon's effect. Most lunar effect studies had not gone into great depth in explaining how and why the moon influenced human conduct. It simply noted that lunar effects might have been expected. Scientific study of lunar effects might best be grouped into two broad categories: (1) the notion that lunar cycle influences certain opportunities for criminal acts and (2) the notion that the moon influences human behavior in some measurable manner. Prior research tended to frame inquiry in light of the latter hypothesis—that lunar cycles influenced rates of aberrant behavior.

The former category had received less scholarly inquiry, perhaps because it implied the effect of the moon was far less direct. Rather than actually causing human behavior, this perspective suggests that rational choices concerning criminality are influenced by a number of

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variables, including lunar illumination. Under this line of thinking, a full moon does not actually cause offenders to commit criminal acts; rather, the illumination provided by a full moon serves to facilitate or hinder certain forms of criminal conduct. Rational offenders might include lunar illumination in making assessments about their behaviors. Just as a burglar would look for a property offering easy entry and with limited guardianship, she/he would also be motivated to avoid committing that crime in well-lit areas, such as those with exterior illumination, street lights, or significant ambient moon light. To do so would be to risk detection by alert citizens or the police.

The latter category, in contrast, was the subject of much of the existing social and behavioral scholarship. The physical sciences have long-established the relationship between the moon and geophysical conditions on earth, particularly the ebb and flow of tides. This relationship led some medical and social science researchers to postulate the high concentration of water in the human body would result in a similar gravitational pull that could have affected human behavior (see Lieber, 1978b, 1996). Although most research followed this line of thinking, the relationship was usually not made explicitly clear. Research was focused on testing the existence of a lunar effect, rather than explaining the actual reason for an observed effect. The vagueness of the mechanisms driving the postulated lunar-behavior relationships complicated efforts aimed at empirical verification.

Studies of lunar effects

Social science research has studied lunar effects using a wide range of methodologies, data sources, populations, and variables. The resulting body of literature tended to suggest weak to non-existent lunar effects, though a few vocal scholars argued improper methodologies were to blame for mixed findings (Cyr & Kaplan, 1987, 1988; Lieber & Sherin, 1972; Templer & Veleber, 1980). As addressed below, the debate over lunar effects was as much a debate over 'proper' methodology as a debate over actual influences. Some contended improper methods resulted in null findings; others argued that stray observed effects tended to disappear upon introducing control variables into an analysis (Bickis, Kelly, & Byrnes, 1995; Durm, Terry, & Hammonds, 1986; Kelly & Rotton, 1983; Rotton, Kelly, & Frey, 1983).

Studies generally failed to find a lunar effect, though researchers found varying associations between lunar phase and some categories of crime (Purpura, 1979), aggression (Lieber, 1978a), violent incidents in correctional settings (Pettigrew, 1985), volume of demand for emergency room services (Blackmon & Catalina, 1973), suicide attempts (Taylor & Diespecker, 1972), hospital admissions (Templer & Veleber, 1980; Weiskott & Tipton, 1975), and calls to telephone counseling services (Templer & Veleber, 1980; Weiskott, 1974). Most studies employed few (if any) controls, used short time frames (i.e., four months, which only measured effects across four lunar cycles), and achieved relatively weak statistical significance, sometimes finding effects on some dependent variables, but not on others. In addition to finding a lunar effect during periods of full moons, studies found effects of new moons—periods when the moon was not reflecting the sun's light back toward earth, making it difficult to observe with the naked eye (Templer & Veleber, 1980; Templer, Veleber, & Brooner, 1982).

Despite these positive associations, the majority of lunar research failed to establish effects. This included failing to find effects on: aggressive acts in prisons (Atlas, 1984; Simon, 1998) and psychiatric facilities (Durm et al., 1986; Quinsey & Varney, 1977), prison escapes (Pettigrew, 1985), use of hospital psychiatric services (Bauer & Hornick, 1968; Shapiro, Streiner, Gray, Williams, & Soble, 1970; Walters, Markley, & Tiffany, 1975), incidents of suicide (Biermann et al., 2005), use of telephone crisis centers (Wilson & Tobacyk, 1990), hospital admissions for dog bite injuries (Chapman & Morrell, 2000), aggression among ice hockey players (Russell & de Graaf, 1985; Russell & Dua, 1983), demands for police and fire services (Bickis et al., 1995; Frey, Rotton, & Barry, 1979), automobile accidents (Campbell & Beets, 1978; Laverty & Kelly, 1998), suicide (Lester, Brockopp, & Priebe, 1969), and homicide (Pokorny & Jachimczyk, 1974). Studies often achieved contradictory results on crime-related outcomes, particularly calls for policing service and homicides. At times, two sets of researchers examined the same data and achieved opposite conclusions (cf. Kelly & Rotton, 1983; Templer et al., 1982) due to inconsistency in conceptualizing and operationalizing key study variables, as well as using different statistical controls and procedures.

Lunar effects on crime

Despite the volume of research testing for lunar effects, few researchers employed crime-related outcomes (exceptions included Cohn, 1993; Purpura, 1979). Where relationships were found lunar influences were modest, particularly in contrast to temporal and situational predictors. There are several reasons to hypothesize that lunar cycles may influence crime, either due to direct effects on human behavior or as a factor influencing rational offenders. First and foremost, though not directly tested in this study, research has shown that belief in lunar effects continued to be strong (Russell & Dua, 1983), including among police officers (Rotton & Kelly, 1985; Rotton et al., 1986; Vance, 1995) and tended to be associated with beliefs in other paranormal phenomena (Rotton & Kelly, 1985). Officers have the benefit of directly observing the aftermath of criminal incidents; their experiences may provide them with unique insights into lunar effects, or police culture may simply perpetuate false beliefs about lunar effects. Second, studies of lunar effects on crime tended to use limited offenses and short time frames, while failing to introduce control variables. This study sought to overcome weaknesses in prior studies by considering a long-time frame, multiple offense types, and salient control variables. Third, moving beyond the beliefs of police officers, there was evidence that beliefs in lunar effects were prevalent. Testing the veracity of these beliefs was of obvious importance.

Is crime influenced by seasons or short-term variations in climate conditions?

One of the first observations about the effects of weather on crime was offered by Belgian statistician Adolphe Quételet (1842/1969), who noted "during summer, the greatest number of crimes against persons are committed and the fewest crimes against property; the contrary takes place during the winter" (p. 90). For over 150 years scholars tested and elaborated on this assertion, introducing broader meteorological data into empirical models. The social contact hypothesis suggests that during times of pleasant weather, aggressive and hostile acts may be more common because there is an increase in normal human interactions, which increases the opportunity for interpersonal conflict. Within weather and crime research, scholars attempted to sort out the social versus physiological effects of weather on human behavior (Cheatwood, 1995).

More contemporary analyses of policing data from American communities tended to find that many types of personal and property crimes were more common during periods of warm versus cool or cold weather (Cheatwood, 1995; Cohn, 1990b, 1996; Cohn & Rotton, 2000; Hipp, Bauer, Curran, & Bollen, 2004; Rotton & Cohn, 2003) and that demand for police services were greater during periods of warmer temperature and longer hours of daylight (i.e., spring and summer) (Cohn, 1996; Heller & Markland, 1970; LeBeau & Corcoran, 1990; LeBeau & Langworthy, 1986).[1] Research suggested this relationship generally held true, though there were upper limits. Rotton and Cohn (2000) found disorderly conduct and assault in Minneapolis had an 'inverted U-shaped' relationship; during periods of extreme heat and cold these behaviors were less frequent. In

reviewing early weather and crime research, Cohn (1990a) observed research established stronger relationships for personal than property crimes, noting

> assaults, burglary, collective violence, domestic violence, and rape tend to increase with ambient temperature…The relationship between heat and homicide is uncertain. High temperatures do not appear to be correlated with robbery, larceny, and motor vehicle theft. (p. 61)

When analyses accounted for temporal variables (i.e., time of day, weekends, holidays, periods when public schools are not in session), weather effects offered relatively modest explanatory effects (Cheatwood, 1995; Cohn, 1993). The influence of temporal and weather variables were presumably a result of changes in routine activities of offenders and victims (e.g., Cohen & Felson, 1979), though these effects might be trumped by situational variables (Rotton & Cohn, 2000).

'Methodological chaos'

A significant challenge surrounding the study of lunar effects on human behavior is the imprecision of this cultural lore. What, exactly, is the moon supposed to influence and how is that influence exercised? Such basic questions hold tremendous implications for conceptual, operational, and analytical decisions. Similar concerns are noted in literature examining weather-crime relationships (Block, 1983, 1984).[2] How, for example, should lunar phase be defined and measured?[3] Also important to consider is whether the relationship is based on the moon's visibility, which would suggest restricting an analysis to nighttime hours and controlling for salient weather conditions?[4] If there is an effect on crime, is it the quality of crime (i.e., offenders act more 'crazy' than normal), quantity (i.e., the volume of crime), or both? Will crime-related effects translate into police records in an observable manner? The contention that existing "methodological chaos has made impossible any consistency in results in the evaluation of the lunar hypothesis" (Cyr & Kaplan, 1987, p. 391) was well founded. While characterizing previous efforts to study this alleged phenomenon as chaotic may be overly dramatic, such difficulties should be expected when scholars sought to study a vague, ill-defined, and indistinct dimension of western cultural lore.

Decisions concerning proper data sources, variable structures, operational definitions, and statistical tests, among other considerations, were not straight-forward. Block (1983) noted a similar assessment when testing for seasonal effects on crime. Her monograph offered a number of insightful parallels to analyzing lunar effects. For example, Block noted researchers were typically constrained by the quality and structure of the data at hand; even when there was great control over data sources and variable structures, there were few clear rules for conducting analyses. Given the folklore origins of the lunar effect, researchers did not have a clear map informing choices concerning the selection of dependent and independent variables, or the analytical methods used to examine data. This situation certainly contributed to the widely varying methodologies and results observed across salient research literature.

Research objective

The purpose of this study was to test the effects of lunar phase on criminal and criminal and disorderly behavior through the construct of methodological framework more rigorous than those found in many prior studies. San Antonio, Texas, is located in the southwestern United States and has a population of more than one million residents. Using call for service (CFS) to the San Antonio Police Department (SAPD) (e.g., 911) over a five-year period (2001-2005) as a measure of crime and disorder, a time-series design was used to determine the linear relationship between lunar cycles and levels of reported crime and disorder. Calls for service that occurred during nighttime hours (8 p.m. – 3 a.m.) were grouped into seven categories: *assaultive violence, burglary, theft, drugs/vice, traffic, other disturbances,* and *aggregated CFS* (the sum of the six categories). In so doing, the study attempted to control for two competing perspectives about the influence of lunar phase. First, did lunar phase itself appear to influence activities reported to the police; did lunar phase produce a quantitative shift in human behavior as measured by the volume of select categories of calls to the police? Second, could lunar phase create conditions that would enhance or diminish the rationality of select offenses? The research design accounted for potential impacts of land use issues by analyzing citywide trends, but also considered trends in both San Antonio's entertainment area and non-entertainment areas.

Methodology

The analysis relied on five years (2001-2005) of data for police calls for service and National Weather Service (NWS) records that depicted San Antonio's weather patterns during the same period. As state above, the purpose of this research was to determine if there was a relationship between lunar cycles and nightly crime levels, a perception that was embedded in the folklore shared by both police personnel and citizens. The analysis first considered descriptive analysis of variables along with bivariate correlation analysis; this was followed by multivariate and time series analysis on each of the dependent variables to determine the impact of lunar cycles on levels of crime and disorder.

Dependent variables

CFS data represented instances of crime and disorder that were received by the dispatch unit of the SAPD and are more typically known as "911 calls" to most citizens. The data provided by SAPD's crime analysis unit were limited to calls of direct jurisdiction of law enforcement (i.e., requests falling under the jurisdiction of other service providers were not included). Incidents of concern to law enforcement typically involved alleged crimes or other incidents requiring that an officer be dispatched to a scene. During the time period under consideration, SAPD received approximately 900,000 CFS per year; this resulted in approximately 225,000 completed police incident reports per year. Annually, approximately 130,000 CFS concerned the six disorder categories considered in this analysis.

Nightly counts of crime and disorder were computed for seven CFS categories: assaultive violence, burglary, theft, drugs/vice, traffic, other disturbances, and aggregated CFS. Nighttime was operationalized as reported incidents between 8 p.m. to 3 a.m. Using January 2, 2001 as an example, total nighttime CFS were calculated for calls received between 8 p.m. on January 1 and 3 a.m. on January 2, 2001. San Antonio has a well-known and established entertainment district (the Riverwalk) within its borders. The Riverwalk draws a high volume of tourists and residents to restaurants, bars, hotels, convention facilities, shops, and other entertainment venues. To account for possible land use effects (see Brantingham & Brantingham, 1995; Robinson & Rengert, 2006) CFS totals were computed for the entire city, the non-entertainment area alone, and the entertainment area alone. This strategy allowed for consideration of any possible interplay with land use (see Table 1 for descriptive statistics).

Independent variables

The key independent variable, *lunar phase,* was a continuous level variable that measured the where the moon was in its lunar cycle at midnight during each date in the analysis. This data were publicly available from the Astronomical Applications Department of the U.S.

Table 1
Descriptive statistics for nightly totals (n = 1826)

	Citywide Totals				Non-Entertainment Area				Entertainment Area Only			
	Min.	Max.	Mean	Std. Dev.	Min.	Max.	Mean	Std. Dev.	Min.	Max.	Mean	Std. Dev.
Totals	0	806	359.81	101.12	0	750	340.97	96.11	0	111	21.80	15.84
Assaultive Violence	0	72	19.38	9.51	0	65	17.62	8.73	0	47	4.55	5.84
Burglary	0	265	58.09	19.32	0	255	55.09	18.54	0	26	2.99	2.61
Theft	0	16	2.11	1.85	0	16	1.90	1.76	0	13	0.39	1.13
Drugs/Vice	0	32	10.97	5.61	0	32	10.14	5.31	0	15	0.83	1.31
Traffic	0	84	23.45	9.29	0	83	22.07	8.70	0	11	1.38	1.62
Disturbances	0	599	226.91	74.14	0	573	216.24	71.10	0	50	10.66	7.52
Lunar Phase	0	1	0.50	0.35								
Winter	0	1	0.33	0.47								
Weekend	0	1	0.29	0.45								
Sunset	1735	1938	1843.72	71.61								
Nightly Temp	31	86	65.21	12.90								
Precip	0	9.5	0.10	0.39								

Naval Observatory (see http://aa.usno.navy.mil). The variable ranged from 0 (a new moon night) to 1.00 (a full moon night); this value was based on the presumption of a clear sky and did not take into account any weather conditions that might have obstructed the actual visibility of the moon.[5] Each night constructed for the dependent variable was paired with the respective lunar phase at midnight. In other words, the dependent variable consisted of CFS counts for each night (8 pm – 3 am) in the five years under consideration; these nights were paired with the lunar phase reported for midnight on that same night. This approach represented a substantial advancement in this area of study. Prior research tended to operationalize lunar phase in dichotomous (full moon versus non-full moon periods) (see Atlas, 1984; Cohn, 1993; Purpura, 1979) or basic ordinal terms (full moon, new moon, and "interphase"; new moon, first quarter, full moon, last quarter) (see Kelly & Rotton, 1983; Pokorny & Jachimczyk, 1974; Templer et al., 1982). These approaches restricted the lunar phase to nominal or ordinal variability; this analysis employed a more robust ratio variable to represent lunar phase.

Control variables were included to account for possible seasonal, temporal and weather effects that might have mediate lunar effects. *Winter* accounted for seasonal fluctuations in weather that might have affected socialization patterns related with rates of crime. Winter was a dummy variable where "1" indicated dates that fell between December 1 and March 31. It was expected that crime patterns would naturally decrease during winter months and then increase during other months (see Cheatwood, 1988). The variable *weekend*, also a binary variable, was coded as "1" to represent Fridays, Saturdays, and Sundays. Social patterns that influence levels of crime and disorder were expected to independently affect nightly crime patterns.

Additional control variables represented weather patterns and were derived from the National Climatic Data Center (NCDC), a division of the National Oceanic and Atmospheric Association. NCDC records are based on data and observations collected by instruments and human observers at NWS stations around the country. Data from the NWS station located at the San Antonio International Airport were used to represent weather. These controls were important because if lunar cycles influenced the opportunity for crime through increased visibility, such effects could have been diminished by inclement weather that obscures such visibility. Weather also had the capacity to influence social patterns that may have independently influenced crime and disorder levels.

Sunset was a continuous variable that identified the official time of sunset based on a twenty-four hour (military) clock. Time of sunset may have influenced social patterns that also affected crime levels. *Nightly temp* reflected the temperature recorded by the NCDS in degrees Fahrenheit. The NCDS data included temperature observations taken at three hour increments thorough the day. For this analysis mean nightly temperatures were computed using the 9 pm, midnight, and 3 am observation periods. The temperature was expected to be positively associated with crime levels. Finally, *precipitation* was a continuous variable that measured precipitation (in inches) during the twenty-four hours on each day. This measure was a proxy indicator of the overall extent to which prevailing weather patterns might have made criminal acts less favorable. Levels of crime and disorder were expected to be negatively associated with precipitation. See Table 1 for descriptive statistics.

Analysis and findings

To test for possible lunar effects on crime and disorder levels, analyses of nightly crime trends was done while controlling for temporal and weather variables that may mediate any apparent effects. The analysis included univariate descriptive statistics that describes each of the independent variables across the three land use types (e.g., citywide, non-entertainment area, and entertainment area only). In addition, bivariate and multivariate statistics were used to determine the relationships between lunar cycles and crime while controlling for other possible explanatory variables. The multivariate analysis included time series design commonly referred to as autoregressive moving average (ARIMA) technique or ordinary-least squares regression. The exact analytical techniques used were based on a preliminary analysis of time or season-related patterns that required statistical control. A diagnostic tool available in the SPSS was used to automatically determine if time-or-season-dependent trends existed in each trend. When no such patterns were evident, simple OLS analysis was used. When time-dependent trends were apparent, time-series analysis was used to control for these patterns.

The descriptive statistics are included in Table 1. There were 1,826 nights included in the study period of January 1, 2001 to December 31st 2005. These nightly units comprised each unique observation or unit of analysis. The statistics included in the top half of Table 1 provide summary measures of nightly crime totals (counts) for aggregated crime and the six subcategories (assaultive violence, burglary, theft, drugs/vice, traffic, and disturbances) for all three areas of the city. It is important to note that these crime classifications were based on how events were classified in call for service (911) data and not official police reports. This method of measuring crime and disorder did not take into account if police failed to file a police report or changed the classification of an incident to another category than originally classified in the call data. Thus, the categorizations reflected those made by call takers after consultation with complainants/victims. An advantage of this approach was removing the possibly biasing effects of officer beliefs; if officers believed crime increased during full moon phases they may have had a proclivity to categories incidents as criminal and/or more serious in nature.

A comparison of the absolute values of average nightly counts across geographical areas was not valid because the areas included different geographical sizes with different size populations at risk. The data presented in Table 1 indicated that the average number of calls for service reporting criminal situations was approximately 360 per night with a range 806 reports (*see* citywide totals). The largest single group of reported crimes/disorders was the "disturbances" category for the citywide data, but also for the entertainment and non-entertainment areas. This category was a very broad grouping that included a wide-range of problematic behavior including disorderly persons, loud parties, suspicious persons, etc. It amounted to a "catch all" classification for events that did not fall neatly into other categories. The next largest categories were burglary and assaultive violence for both the citywide and non-entertainment area totals. The average nightly totals for assaultive violence ($\bar{x} = 4.55$) were higher in the entertainment area compared to other sectors of the city. This was likely due to differences in land use patterns and the nature of socialization patterns (e.g., high density of bars and other entertainment establishments).

The second grouping of variables included the principle independent variables, lunar phase, and five additional variables that controlled for seasonal (winter), temporal (weekend and time of sunset), and weather (nightly temperature and precipitation) variations. The average lunar phase across the observation time was fifty-percent. The sunset time was measured on a military time scale that ranges from 0-2400; the average time of sunset was 1843 hours, or 6:43 pm. The average temperature during the nightly observation periods was 65 degrees (Fahrenheit). Finally, there was approximately .10 inches of daily precipitation during the study period, though an appreciable range was noted on that variable.

Bivariate analysis

Bivariate correlations are included in Table 2. At the bivariate level, the data suggested there was no relationship between lunar phase and crime. This relationship generally held for citywide disorder patterns, but also for crime trends in non-entertainment and entertainment areas with one exception. The relationship between drugs/vice crimes in the entertainment district was significant and negative, although the coefficient was relatively small. This relationship suggested that while illumination was not a factor in crime, the influence was dependent on land use patterns. It was also noteworthy that many of the temporal, seasonal and weather control variables were significant across the data, largely in the expected directions.

Table 2
Bivariate Correlations

	Lunar Phase	Winter	Weekend	Sunset	Nightly Temp	Precip
City Traffic	-0.00	-0.27**	0.57**	0.26**	0.29**	0.05*
City Burglary	0.02	-0.16**	0.24**	0.25**	0.21**	0.14**
City Disturbance	0.00	-0.26**	0.79**	0.22**	0.26**	-0.08**
City Assault	-0.02	-0.23**	0.71**	0.19**	0.25**	-0.07**
City Drugs/Vice	-0.01	-0.32**	0.22**	0.31**	0.34**	-0.09**
City Theft	-0.01	-0.12**	0.15**	0.14**	0.11**	-0.02
City Aggregated	0.00	-0.31**	0.78**	0.29**	0.32**	-0.05*
NonEnt Traffic	-0.00	-0.27**	0.55**	0.26**	0.29**	0.06*
NonEnt Burglary	0.02	-0.17**	0.24**	0.25**	0.22**	0.14**
NonEnt Disturbance	-0.00	-0.26**	0.79**	0.23**	0.26**	-0.08**
NonEnt Assault	-0.01	-0.23**	0.70**	0.19**	0.25**	-0.07**
NonEnt Drugs/Vice	0.00	-0.31**	0.19**	0.31**	0.35**	-0.09**
NonEnt Theft	-0.00	-0.11**	0.12**	0.13**	0.11**	-0.03
NonEnt Aggregated	0.00	-0.31**	0.78**	0.29**	0.32**	-0.05*
Ent Traffic	0.02	-0.11**	0.30**	0.10**	0.10**	-0.01
Ent Burglary	0.01	-0.01	0.08	0.03	0.01	0.06
Ent Disturbance	0.01	-0.12**	0.33**	0.11**	0.10**	-0.05*
Ent Assault	-0.03	-0.10**	0.33**	0.09**	0.08**	-0.02*
Ent Drugs/Vice	-0.06*	-0.10**	0.17**	0.09**	0.06*	-0.02
Ent Theft	-0.04	-0.05	0.13*	0.05	0.01	0.06**
Ent Aggregated	-0.01	-0.13**	0.35**	0.12**	0.10**	-0.03

* p<.05.
** p<.01.

Winter was a seasonal control variable; it was hypothesized that due to changes in season-related socialization patterns, crime would likely be lower during the winter. The significant and negative relationship across crime types and locations indicates that crime/disorder was generally lower during winter months, even in such a temperate climate. *Weekend* was a temporal control that depicted if the observation period occurred on Friday, Saturday, or Sunday. Related again to natural variations in socialization patterns linked to day-of-the-week, a positive relationship was expected. That is, more crime was expected on the weekends. The hypothesis was supported by the significant and positive relationships across crime types and geographical locations, relationships that were greater than 0.7 in several cases. The data presented in Table 2 also indicated a consistent significant and positive relationship between daily sunset and crime. This indicated that crime increased as sunset was delayed. This finding was interesting because it suggested levels of crime were positively associated with levels of solar illumination.

Finally, the data also indicated strong relationships between levels of crime/disorder and both average nightly *temperature* and levels of *precipitation*. The significant and positive coefficients for temperature indicated that crime increased during warmer days across geographical locations. Finally, a pattern emerged suggesting that when significant, the relationship was generally negative. This indicated that crime decreased on rainy nights. Interesting, the relationship for precipitation and crime was less apparent in the entertainment area which might suggest that tourists were less deterred by bad weather.

The bivariate analyses indicated that while all of the control variables were significantly related to levels of crime and disorder, lunar phase demonstrated little explanatory power. With the exception of levels of drugs and vice in the entertainment area, lunar phase showed no significant relationships. Moreover, the direction of the relationships was scattered across types of disorderly/criminal behavior and geographical areas. Results of the bivariate analysis seemed contrary to the lore of a lunar affect on crime and disorder; in fact the weak drugs/vice finding in the entertainment area is contrary to what lore would predict. To further test this relationship, multivariate analysis (both ordinary least squares regression and time series analysis) was used to understand the relationships between lunar phase and crime while controlling for other temporal, seasonal, and weather related conditions.

Multivariate analysis

Time-series analysis was an appropriate analytical strategy for regressing time-and-season dependent variables on independent variables. The autoregressive integrative moving average model (ARIMA) was developed by Box and Jenkins (1976) as a methodological strategy for removing trends from data. ARIMA analysis involves an iterative model building process where the analyst diagnoses the structure of the trend and then builds the appropriate statistical model to these biasing effects that may distort statistical relationships. ARIMA models have three structural parameters that must be diagnosed and modeled, autoregressive (p); difference (d); and moving average (q) parameters (see McDowall, McCleary, Meidinger & Hay, 1980).

The first step in constructing these models is to ensure trends are *stationary*. Stationary refers to the degree to which the data series fluctuates around a fixed mean. A nonstationary trend is represented by a non-zero integer in the *d* term. The differencing process involves subtracting a value from the preceding k^{th} observations with *k* representing the *d* parameter. The *autoregressive* parameter reflects the mathematical relationship between an observation and *k* preceding values. Finally, the moving average parameter (*q*) is similar

to the autoregressive parameter except that it represents the affects of past error that cannot be modeled with the autoregressive parameter. The iterative process described above can be labor intensive and non-precise as the analyst visually interprets graphs (correlograms) to determine the best fit for the data. SPSS 14.0, however, includes a time series modeler that automates this process by running through a series of iterations and identifying the best model for the data series. This modeler is useful as it reduces the level of subject interpretation associated with identifying the proper parameter estimates (*see* Bushway & McDowall 2006) for a discussion on the challenges associated with establishing causal effects in trend data).

Tables 3–5 present the multivariate findings for the three geographical areas (citywide, non-entertainment, and entertainment areas).[6] Each table includes seven different models, one for each of the crime categories; a description of the model types is located below the categories. The ARIMA parameter estimates are included when applicable and OLS indicates a simplified regression model was used. As indicated above, these model types were determined through diagnostic procedures available in the statistical software package used.

The citywide analysis is presented in Table 3. The discussion will focus primarily on the relationships between lunar phase and not the other control variables for reasons of brevity (seven categories of crime across three geographical areas). Looking across the citywide analysis, lunar phase was significant only for the burglary model and in the positive direction. This suggested that as lunar phase increased (i.e., the moon became more full), so did levels of burglary. While the lunar phase-crime relationship was positive across the other categories (with the exception of assault and theft) none of these reached statistical significance. The relationships among the control variables and crime levels largely remained unchanged in the multivariate models, with the exception of *sunset* which was relegated largely insignificant across the models.

The findings for the non-entertainment area are detailed in Table 4. This area includes the entire city of San Antonio minus the Riverwalk district. Similar to Table 3, these findings indicated that lunar phase had no effect on levels of crime and disorder in San Antonio. The relative impact of the *sunset* variable was also moderated in these models; sunset was significant in only the burglary and theft models, exerting a positive relationship in both instances.

Finally, the findings for the entertainment area are presented in Table 5. Looking across the seven models, it is apparent that the seasonal, temporal, and weather-related control variables that were so prominent in most of the bivariate relationships and the prior two multivariate tables largely disappear in Table 5. This suggested that after including the additional control variables and detrending the data, crime and disorder levels in the entertainment district were influenced to a lesser degree by these factors. The one notable exception, not unexpectedly, was the *weekend* control variable. That is, crime and disorder levels were significantly greater in the entertainment area on weekends net all other controls. This may suggest that socialization patterns that explain the occurrence of crime and disorder are largely "fixed" regardless of the weather, temperature, and season. It is also interesting to note that while the relationships between lunar phase and crime levels were not significant across the models, there was one exception; the relationship between lunar phase and drugs/vice was significant and *negative*. This indicates that as lunar phase increased (i.e., the moon trended toward a more full state), the reported levels of drugs and vice *decreased*.

Discussion

Lunar lore is an established aspect of western culture, though the specifics of this belief (i.e., how and why the moon might exert an influence on human behavior) was imprecise. This study attempted to determine whether lunar phase influenced disorderly and criminal acts as indicated by the volume of incidents reported to the police each night during a five year period in a major southwestern US city. If a presumed lunar effect was supposed to influence humans through some form of biosocial mechanism (Lieber, 1978b, 1996) the findings reported here offered no real support of this supposition using the dependent variable at hand. Prior studies were confirmed here; there was no clear evidence that lunar cycles had more than marginal (and likely spurious) explanatory power in understanding levels of crime and disorder. Although popular culture, folk lore, and even certain occupational lore suggested the "freaks" come out during full moons (Lieber, 1996; Rotton & Kelly, 1985; Rotton et al., 1986; Vance, 1995), this phenomenon was not reflected in San Antonio police data as used here. Though a small number of associations were noted between lunar phase and various aspects of criminal and disorderly conduct, this was a common element of prior research and could have been a probable effect of the large number of associations under consideration (i.e., a spurious finding). A Bonferroni correction to address this concern could also have been performed to decrease the possibility of this Type 1 error. The few statistically significant associations that were detected and the impact of other variables other than the lunar phase suggest that such a procedure, while more accurate, would not substantively impact these findings or conclusions.

This study relied on CFS, which captured the quantity of reported incidents, but did not provide robust insights into qualitative aspects of police encounters involving crime and disorder. CFS were good data points as they were immune from officer discretion, though not call-taker discretion. It was common, however, for lunar research to focus on the volume of select forms of behavior, such as violence and aggression in prisons and psychiatric facilities (Lieber, 1978a, 1978b; Pettigrew, 1985; Templer & Veleber, 1980; Weiskott & Tipton, 1975) or calls to crisis centers (Templer & Veleber, 1980; Weiskott, 1974). This was likely a partial function of convenience; quantitative/volume indicators of behavior were far more convenient and inexpensive than

Table 3
Multivariate analysis - City Level Analysis

Model Type	Traffic		Burglary		Disturbances		Assault		Drugs/Vice		Theft		Aggregated	
	ARIMA(0,0,8)		(OLS)		ARIMA(0,0,8)		ARIMA(7,0,8)		(OLS)		(OLS)		ARIMA(7,0,8)	
	B	StdError	B	StdError	B	StdError	B	StdError	B	StdError	B	StdError	B	StdError
Variable														
Sunset	0.009	0.006	0.067*	0.009	-0.008*	0.032	-0.003	0.004	0.007*	0.003	0.002*	0.001	0.050	0.046
Winter	-1.738*	0.851	4.116*	1.460	-21.871*	4.701	-2.470*	0.656	-1.318*	0.412	-0.140	0.148	-23.848*	6.703
Weekend	11.372*	0.403	10.361*	0.927	126.698*	2.470	15.410*	0.630	2.719*	0.261	0.602*	0.094	190.794*	4.763
Nightly Temp	0.126*	0.024	0.154*	0.050	1.133*	0.139	0.138*	0.020	0.091*	0.014	0.003	0.005	2.002*	0.187
Precip.	1.008*	0.407	6.510*	1.067	-16.697*	2.282	-1.814*	0.362	-1.569*	0.301	-0.133	0.108	-13.978*	2.835
Lunar Phase	0.102	0.670	1.455*	1.194	2.214	3.633	-0.299	0.472	0.023	.0336	-0.006	0.121	4.083	5.144
Constant	-5.031	10.434	-80.994*	16.757	139.067*	57.315	13.385	7.985	-7.638	4.722	-2.772	1.699	88.983	83.023

* $p<.05$.

Table 4
Multivariate analysis - Non-Entertainment District Analysis

Model Type	Traffic		Burglary		Disturbances		Assault		Drugs/Vice		Theft		Aggregated	
	ARIMA(0,0,8)		(OLS)		ARIMA(0,0,8)		ARIMA(7,0,8)		ARIMA(0,0,14)		(OLS)		ARIMA(7,0,8)	
	B	StdError	B	StdError	B	StdError	B	StdError	B	StdError	B	StdError	B	StdError
Variable														
Sunset	0.009	0.005	0.065*	0.009	-0.009	0.030	-0.006	-0.005	0.005	0.003	0.002*	0.001	0.044	0.045
Winter	-1.547	0.799	3.956*	1.401	-20.723*	4.515	-2.341*	0.619	-1.076*	0.467	-0.080	0.141	-22.445*	6.519
Weekend	10.39*	0.381	9.878*	0.889	121.390*	2.376	0.351*	0.188	2.997*	0.329	0.462*	0.090	174.976*	5.079
Nightly Temp	0.119*	0.023	0.157*	0.048	1.100*	0.133	8.248*	0.909	0.099*	0.015	0.003	0.005	1.934*	0.180
Precip.	1.053*	0.39	6.149*	1.024	-15.588*	2.197	0.138*	0.019	-1.393*	0.273	-0.157	0.103	-13.147*	2.716
Lunar Phase	0.018	0.628	1.355	1.145	1.970	3.487	-1.684	0.334	0.206	0.295	0.021	0.116	4.018	4.975
Constant	-4.848	9.759	-79.468*	16.069	134.465*	55.044	17.015*	8.286	-6.004	5.684	-2.931	1.623	89.851	81.004

* $p<.05$.

qualitative indicators, which also suffered from methodological concerns and limitations.

It is possible that arrest data might be a more accurate representation of the quality of calls police handle. Based on this logic, incidents occurring during times of full moon would be expected to be more atypical and would result in a greater need for officers to intervene with an arrest. This logic, however, allows for the introduction of officer discretion. Given that lunar effects are embedded in collective western beliefs (Lieber, 1996; Rotton & Kelly, 1985; Rotton et al., 1986), affects observed in areas heavily influenced by officer discretion (such as the decision to arrest, file an official report, or make referrals) could suffer from social contagion (Purpura, 1979; Simon, 1998). If officers accept that there are lunar effects (Rotton et al., 1986; Vance, 1995) they may opt for differential handling of situations based on lunar phase. In effect, the lunar effect would become a self-fulfilling prophecy; dependent variables would be influenced due to acceptance of the lore, rather than due to actual citizen/offender behavior. For this reason, the initial classifications of CFS represent a relatively innocuous indicator of situations brought to the attention of the police, though they are subject to some social contagion among 911 call takers.

The findings of this research, rather than confirming a lunar-crime/disorder relationship, corroborated earlier literature establishing that crime varied temporally (Cohn, 1996; Heller & Markland, 1970; LeBeau & Corcoran, 1990; LeBeau & Langworthy, 1986) and due to weather (Cheatwood, 1995; Cohn, 1990b; Cohn & Rotton, 2000; Hipp et al., 2004; Quételet, 1842/1969; Rotton & Cohn, 2003). Weekends and nightly temperature were consistently and positively associated with aggregated levels of crime, though there was variation based on specific offense categories. Rates of aggregated crime were much higher on weekends and were higher during periods of warmer temperatures. During winter months and periods of greater precipitation, crime decreased across the city as a whole and within the non-entertainment areas. Interestingly, winter and precipitation did not influence aggregated crime within the entertainment district.

Substantive lunar effects on crime were not found in the data analyzed here. If any interpretations regarding the few (and possibly spurious) relationships were offered, a logical starting point might be rational choice notions. The mechanisms of influence are likely a function of some effects on the availability of suitable targets and the ability of offenders to escape (or afford) adequate opportunities to conduct their activities. The limited influence of lunar phase in the two instances: (1) citywide burglary (positive relationship found which might support lunar impacts) and (2) entertainment district drugs/vice (negative relationship found which may be interpreted to undermine lunar lore) may be suggestive of such perspectives. On the whole, however, the data and models examined here were not able to specify insights or details pertaining to these incidents that would shed light on this contention. Further scholarly inquiry considering the choices and decisions of these types of offenders might, for example, question the role of ambient moon light in shaping offending choices and behaviors.

That noted, insistent believers in the existence of a lunar effect may interpret this study differently and offer an alternative possibility. One could review this study and contend that while this lunar cycle research failed to find effects on the volume of crime, the possibility of effects on the varying character or quality of crimes reported may remain. More precisely, lunar effects may shape not the volume of crime encountered by police and other service providers, but rather alter the nature of problems, individuals, and circumstances. As the data used in this study were aggregated and quantitative, they offered limited insight into these possible aspects of the nature and character of individual incidents and the motivations and/or rationales of offenders. For the lunar contention to be adequately tested and explored further study employing greater methodological rigor (as this study has employed in examining the

Table 5
Multivariate analysis - Entertainment District Analysis

Model Type	Traffic		Burglary		Disturbances		Assault		Drugs/Vice		Theft		Aggregated	
	ARIMA(4,0,7)		(OLS)		ARIMA(7,0,7)		ARIMA(0,0,14)		ARIMA(5,0,9)		(OLS)		ARIMA(7,1,13)	
	B	StdError	B	StdError	B	StdError	B	StdError	B	StdError	B	StdError	B	StdError
Variable														
Sunset	0.001	0.001	0.002	0.001	0.009	0.009	0.002	0.005	0.001	0.001	0.001	0.001	0.024	0.020
Winter	-0.194	0.155	0.160	0.212	-1.038	0.713	-0.244	0.769	-0.202	0.155	-0.125	0.091	-1.636	1.644
Weekend	0.995*	0.078	0.483*	0.134	4.785*	0.578	4.033*	0.288	0.495*	0.065	0.328*	0.058	9.411*	1.223
Nightly Temp	0.004	0.005	-0.003	0.007	0.059*	0.017	0.032	0.019	0.003	0.004	-0.005	0.003	0.137*	0.037
Precip.	-0.055	0.081	0.361*	0.155	-1.051*	0.248	-0.228	0.297	-0.093	0.070	0.185*	0.066	-0.776	0.510
Lunar Phase	0.087	0.104	0.099	0.173	.0256	0.328	-0.346	0.561	-0.206*	0.100	-0.119	0.074	-0.280	0.804
Constant	-0.858	2.470	-1.526	2.429	-9.690	16.345	-2.819	9.958	-0.614	2.582	-0.646	1.043	-32.233	37.118

* $p<.05$.

volume of crime) would be necessary in an effort to examine the contours of any possible relationship between the quality of crimes reported and lunar cycles. Only then could this question of the lunar lore and crime be more fully answered.

Notes

1. See Rotton and Cohn (2000) and Cohn (1990b), among others, for a discussion of theoretical and empirical relationships between weather, temporal variables, social contact variables, and crime.

2. Block (1984) wrote that although some general seasonal trends could be noted, they tended to be offense-specific and were not evident in all jurisdictions. Her comprehensive review of data she analyzed, as well as various published and unpublished research done by others, found ample variation in seasonal trends. Some of this might have been attributed to variable data, operational definitions, and analytical plans.

3. Researchers have employed myriad methods of structuring the timing and intensity of full moons relative to other periods of the lunar cycle. For example: contrasting the day of the full moon with all other days in the cycle (Frey et al., 1979); creating seemingly-capricious "windows" of time (i.e., three days) around the full moon for contrast with the rest of the cycle (sometimes separating out windows of time around the new moon) (Walters et al., 1975); breaking cycles into equal (Frey et al., 1979; Quinsey & Varney, 1977; Taylor & Diespecker, 1972) and unequal (Frey et al., 1979; Lester et al., 1969) periods of times; and, allowing lunar phase to vary from day to day throughout the lunar cycle (Simon, 1998). The lunar lore is ambiguous regarding whether the influence of the moon is truly restricted to full-moon periods and whether a heightened full moon influence might be offset by a converse effect during the new moon.

4. This consideration was another complexity created by the vague nature of the lunar lore. Was the effect of the full moon mediated by its visibility due to daylight and/or weather patterns? If the effect was thought to result from the actual intensity of the moon's illumination, the answer may have been "yes." If the effect was thought to result from the moons 'pull' on water in the human body, the answer might have been "no."

5. An anonymous reviewer pointed out the U.S.N.O. also reports moon rise and setting times within archival data. It was noted using a sliding window of analysis based on whether the moon was above the horizon might have been an alternative approach within the analysis. Additional analyses not reported here, but available from the lead author upon request, suggest the results were not substantively different with the use of such a variable window of analysis. The original models (fixed 8:00 pm – 3:00 am window of analysis) were retained for the analysis reported in this article, though the alternative scheme was included in later portions of the discussion.

6. The analysis was also conducted using a measure of the moon's actual visibility above the horizon net of atmospheric conditions that might preclude such visibility. These models yielded no significant differences in parameter magnitudes or significance levels. Since the same pattern of significant and non-significant results was obtained, the initial results were retained and presented in this article. Those seeking further information pertaining to these alternative modeling efforts can direct inquires to the second author.

References

Atlas, R. (1984). Violence in prison: Environmental influences. *Environment and Behavior*, *16*, 275—306.

Bauer, S. F., & Hornick, E. J. (1968). Lunar effect on mental illness: The relationship of moon phase to psychiatric emergencies. *American Journal of Psychiatry*, *125*, 696—697.

Bickis, M., Kelly, I. W., & Byrnes, G. F. (1995). Crisis calls and temporal and lunar variables: A comprehensive examination. *Journal of Psychology*, *129*, 701—711.

Biermann, T., Estel, D., Sperling, W., Bleich, S., Kornhuber, J., & Reulbach, U. (2005). Influence of lunar phase on suicide: The end of a myth? A population-based study. *Chronobiology International*, *22*, 1137—1143.

Blackmon, S., & Catalina, D. (1973). The moon and the emergency room. *Perceptual and Motor Skills*, *37*, 624—626.

Block, C. R. (1983). *How to handle seasonality: Introduction to the detection and analysis of seasonal fluctuation in criminal justice time series.* Chicago: Illinois Criminal Justice Information Authority.

Block, C. R. (1984). *Is crime seasonal?* Chicago: Illinois Criminal Justice Information Authority.

Box, G. E. P., & Jenkins, G. M. (1976). *Time series analysis: Forecasting and control* (Rev. ed.). San Francisco: Holden-Day.

Brantingham, P., & Brantingham, P. (1995). Criminality of place: Crime generators and crime attractors. *European Journal on Criminal Policy and Research*, *3*(3), 5—26.

Bushway, S. D., & McDowall, D. (2006). Here we go again- Can we learn anything from aggregate-level studies of policy interventions? *Criminology & Public Policy*, *5*, 461—470.

Campbell, D. E., & Beets, J. L. (1978). Lunacy and the moon. *Psychological Bulletin*, *85*, 1123—1129.

Chapman, S., & Morrell, S. (2000). Barking mad? Another lunatic hypothesis bites the dust. *British Medical Journal*, *321*, 1561—1563.

Cheatwood, D. (1988). Is there a season for homicide? *Criminology*, *26*, 287—306.

Cheatwood, D. (1995). The effects of weather on homicide. *Journal of Quantitative Criminology*, *11*, 51—70.

Cohen, L. E., & Felson, M. (1979). Social change and crime rate trends: A routine activity approach. *American Sociological Review*, *44*, 588—608.

Cohn, E. G. (1990a). Weather and crime. *British Journal of Criminology*, *30*, 51—64.

Cohn, E. G. (1990b). Weather and violent crime: A reply to Perry and Simpson, 1987. *Environment and Behavior*, *22*, 280—294.

Cohn, E. G. (1993). The prediction of police calls for service: The influence of weather and temporal variables on rape and domestic violence. *Journal of Environmental Psychology*, *13*, 71—83.

Cohn, E. G. (1996). The effect of weather and temporal variations on calls for police service. *American Journal of Police*, *15*(1), 23—43.

Cohn, E. G., & Rotton, J. (2000). Weather, seasonal trends and property crimes in Minneapolis, 1987-1988: A moderator-variable time-series analysis of routine activities. *Journal of Environmental Psychology*, *20*, 257—272.

Culver, R., Rotton, J., & Kelly, I. W. (1988). Geophysical variables and behavior: XLIX. Moon mechanisms and myths: A critical appraisal of explanations of purported lunar effects on human behavior. *Psychological Reports*, *62*, 683—710.

Cyr, J. J., & Kaplan, R. A. (1987). Geophysical variables and behavior: XLVI. The lunar-lunacy relationship: A poorly evaluated hypothesis. *Psychological Reports*, *61*, 391—400.

Cyr, J. J., & Kaplan, R. A. (1988). Investigating the lunar-lunacy relationship: A reply to Rotton and Kelly. *Psychological Reports*, *62*, 319—322.

Durm, M. W., Terry, C. L., & Hammonds, C. R. (1986). Lunar phase and acting-out behavior. *Psychological Reports*, *59*, 987—990.

Frey, J., Rotton, J., & Barry, T. (1979). The effects of the full moon on human behavior: Yet another failure to replicate. *The Journal of Psychology*, *103*, 159—162.

Heller, N. B., & Markland, R. E. (1970). A climatological model for forecasting the demand for police service. *Journal of Research in Crime & Delinquency*, *7*, 167—176.

Hipp, J. R., Bauer, D. J., Curran, P. J., & Bollen, K. A. (2004). Crimes of opportunity or crimes of emotion? Testing two explanations of seasonal change in crime. *Social Forces*, *82*, 1333—1372.

Kelly, I. W., & Rotton, J. (1983). Geophysical variables and behavior: XIII. Comment on "lunar phase and accident injuries": The dark side of the moon and lunar research. *Perceptual and Motor Skills*, *57*, 919—921.

Laverty, W. H., & Kelly, I. W. (1998). Cyclical calendar and lunar patterns in automobile property accidents and injury accidents. *Perceptual and Motor Skills*, *86*, 299—302.

LeBeau, J. L., & Corcoran, W. T. (1990). Changes in calls for police service with changes in routine activities and the arrival and passage of weather fronts. *Journal of Quantitative Criminology*, *6*, 269—291.

LeBeau, J. L., & Langworthy, R. H. (1986). The linkages between routine activities, weather, and calls for police services. *Journal of Police Science and Administration*, *14*, 137—145.

Lester, D., Brockopp, G. W., & Priebe, K. (1969). Association between a full moon and completed suicide. *Psychological Reports*, *25*, 598.

Lieber, A. L. (1978a). Human aggression and the lunar synodic cycle. *Journal of Clinical Psychiatry*, *39*, 385—393.

Lieber, A. L. (1978b). *The lunar effect: Biological tides and human emotions.* Garden City, NY: Anchor Press.

Lieber, A. L. (1996). *How the moon affects you.* Mamaroneck, NY: Hastings House.

Lieber, A. L., & Sherin, C. R. (1972). Homicides and lunar cycle: Toward a theory of lunar influence on human emotional disturbance. *American Journal of Psychiatry*, *129*, 69—74.

McDowall, E., McCleary, R., Meidinger, E. E., & Hay, R. A., Jr. (1980). *Interrupted time series analysis: Vol. 2.1 Quantitative applications in the social sciences.* Newbury Park, CA: Sage.

Merriam-Webster online dictionary. (2008). Retrieved from http://www.m-w.com

Pettigrew, C. G. (1985). Seasonality and lunacy of inmate behavior. *The Southern Psychologist*, *2*(3), 41—46.

Pokorny, A. D., & Jachimczyk, J. (1974). The questionable relationship between homicides and the lunar cycle. *American Journal of Psychiatry*, *131*, 827—829.

Purpura, P. P. (1979). Police activity and the full moon. *Journal of Police Science and Administration*, *7*, 350—353.

Quételet, L. A. J. (1969). *A treatise on man and the development of his faculties.* Gainesville, FL: Scholar's Facsimiles and Reprints. (Original work published 1842).

Quinsey, V. L., & Varney, G. W. (1977). Characteristics of assaults and assaulters in a maximum security psychiatric unit. *Crime and Justice*, *5*, 212—220.

Robinson, J. B., & Rengert, G. F. (2006). Illegal drug markets: The geographic perspective and crime propensity. *Western Criminology Review*, *7*(1), 20—32.

Rotton, J., & Cohn, E. G. (2000). Weather, disorderly conduct, and assault: From social contact to social avoidance. *Environment and Behavior*, *32*, 651—673.

Rotton, J., & Cohn, E. G. (2003). Global warming and U.S. crime rates: An application of routine activity theory. *Environment and Behavior*, *35*, 802—825.

Rotton, J., & Kelly, I. W. (1985). A scale for assessing belief in lunar effects: Reliability and concurrent validity. *Psychological Reports*, *57*, 239—245.

Rotton, J., Kelly, I. W., & Elortegui, P. (1986). Assessing belief in lunar effects: Known-group validation. *Psychological Reports*, *59*, 171—174.

Rotton, J., Kelly, I. W., & Frey, J. (1983). Geophysical variables and behavior: X. Detecting lunar periodicities: Something old, new, borrowed, and true. *Psychological Reports*, *52*, 111—116.

Russell, G. W., & de Graaf, J. P. (1985). Lunar cycles and human aggression: A replication. *Social Behavior and Personality*, *13*, 143—146.

Russell, G. W., & Dua, M. (1983). Lunar influences on human aggression. *Social Behavior and Personality*, *11*, 41—44.

Shapiro, J. L., Streiner, D. L., Gray, A. L., Williams, N. L., & Soble, C. (1970). The moon and mental illness: A failure to confirm the Transylvania effect. *Perceptual and Motor Skills*, *30*, 827−830.
Simon, A. (1998). Aggression in a prison setting as a function of lunar phases. *Psychological Reports*, *82*, 747−752.
Taylor, L. J., & Diespecker, D. D. (1972). Moon phase and suicide attempts in Australia. *Psychological Reports*, *31*, 110.
Templer, D. I., & Veleber, D. M. (1980). The moon and madness: A comprehensive perspective. *Journal of Clinical Psychology*, *36*, 865−868.
Templer, D. I., Veleber, D. M., & Brooner, R. K. (1982). Geophysical variables and behavior: VI. Lunar phase and accident injuries: A difference between night and day. *Perceptual and Motor Skills*, *55*, 280−282.
Vance, D. E. (1995). Belief in lunar effects on human behavior. *Psychological Reports*, *76*, 32−34.
Walters, E., Markley, R. P., & Tiffany, D. W. (1975). Lunacy: A type I error? *Journal of Abnormal Psychology*, *84*, 715−717.
Weiskott, G. N. (1974). Moon phases and telephone counseling calls. *Psychological Reports*, *35*, 752−754.
Weiskott, G. N., & Tipton, G. B. (1975). Moon phases and state hospital admissions. *Psychological Reports*, *37*, 486.
Wilson, J. E., II, & Tobacyk, J. J. (1990). Lunar phases and crisis center telephone calls. *Journal of Social Psychology*, *130*, 47−51.